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## CHEMICAL IDEAS IN MEDICINE AND BIOLOGY<sup>1</sup>

By Sir HENRY DALE

DIRECTOR OF THE BRITISH NATIONAL INSTITUTE FOR MEDICAL RESEARCH

THIS is the second occasion within a period of some eighteen months on which I have been given the pleasant opportunity of taking part in the opening of new research laboratories in this country, supported by your great pharmaceutical industries. I hope I may detect, in this second invitation to take part in a ceremony of this kind, a willingness to regard me still as one of the workers in medical science who have found opportunity for research in laboratories supported by industry, although my work under such conditions came to an end all too many years ago. I shall never regret that experience, or cease to be grateful for the opportunity which it gave me. As I suggested when I spoke last year at Rahway, the immediate objective of research in such laboratories, and the kind of opportunity which it affords, may have their natural and proper differences from those

of the laboratories supported by academic or public endowment. But the differences in result for the progress of medical science are often more formal than real; and it is my hope that the growth of co-operation between those working in these different spheres may yet bring to many the rather rare privilege which has fallen to my own lot of migrating from one to the other, and back again, and thus of knowing at first hand the best that each can offer.

We are opening to-day new research laboratories in connection with a modern pharmaceutical industry. To those of us who can look back over the period which has elapsed since my own student days, the change that has taken place in the scope of pharmacy has a revolutionary aspect. Forty years ago the earliest of the antitoxic sera ranked as recent discoveries, and accurate methods for measuring their activities in tests on animals had just been laid down by Ehrlich, on principles which provided the founda-

<sup>1</sup> Address given at the opening ceremony of the Eli Lilly Research Laboratories, October 11, 1934.

tion of all sound later work on the biological assay of remedies. The first effective application of a hormone in the specific treatment of a disease—that of thyroid extract in myxoedema—was still a novelty, and the remarkable activity of extracts from the suprarenal gland, due to the substance later isolated and named epinephrine or adrenaline, had just been observed. Pharmacy in those days was still predominantly concerned with the traditional drugs which had come into use through empirical observation; and the extracts and tinctures commonly used in practise could be and to some extent still were made on a small scale by the individual retail pharmacist. There was already, of course, some large-scale production even of these old-fashioned, galenical preparations, and a beginning had been made with the manufacture of an early few of the synthetic preparations which are now available in such bewildering multitude and variety. But the therapeutic practise of those days, to an extent which in retrospect from the present position seems almost incredible, was still based almost entirely on an empirical tradition; and, though new additions had from time to time been made to the *materia medica*, the therapeutic outlook and attitude had changed but little for centuries. A beginning had been made by pharmacology towards rationalizing the use of those of the drugs in common use which had an action sufficiently definite to be susceptible to experimental analysis. Towards most of the conventional range of treatment, however, the attitude of the candid physician, no less than of the experimental investigator, was one of sceptical pessimism. For a large proportion even of serious illness he prescribed medicinal treatment because the patient expected it, rather than with any hope of result beyond, perhaps, a minor alleviation of symptoms.

I am not suggesting that such expectant or palliative treatment no longer exists in medical practise or that its complete elimination is to be expected or desired. Alleviation of symptoms not only brings the richest reward of gratitude; it may be the most urgent medical duty. The change, however, towards a rational and fundamental therapeutics, aimed at removing causes or replacing deficiencies, has been, during the period in question, and is still in active progress. One example comes vividly and appropriately to my mind on the present occasion. As a student in the medical wards, I remember hearing a great physician, faced with a case of diabetes, express the view that it would have been better for the patient if his condition had not been discovered. "We can," he said, "at best prolong his life a little, and only at the cost of making it not worth living." The same, indeed, might have been said at any time during a further twenty years from that date; but, speaking in the presence of Sir Frederick Banting,

and in the place where the large-scale production of insulin had its earliest organization, I do not need to remind you of the revolutionary change which has since taken place, with regard to the treatment of diabetes.

The transformation of the whole aspect of one disease by the discovery of insulin has attracted a more general attention than almost any other advance in medical science within our time. For those of us who have been engaged in experimental attempts to trace the complicated story of the functions, transformations and fate of sugar in the normal body, it has represented a physiological advance as important as that which it has effected in medical practise. Yet we may regard this discovery as one item of the wider progressive change in therapeutic method, based upon new knowledge of the causes of disease and aiming at the removal of those causes. Looking at the change as a whole, I think we may distinguish two main contributory factors.

(1) The first was the recognition of infections as due to the invasion of the body by living microorganisms. It is a commonplace that preventive medicine was born of this discovery, but the new knowledge, with its astounding and still progressive development, has also given a new direction to the therapeutics of infective diseases, in the search for remedies specifically killing or limiting the growth of the infecting microorganisms, or specifically neutralizing the poisons which they produce in the infected body. A few of the older remedies, indeed, owed their value to an unconscious application of such specific actions, for the control of infective organisms which modern research has since identified; but I can only think of some three or four of such specifically acting drugs which the old empirical pharmacy bequeathed to us—cinchona, ipecacuanha, mercury and the iodides. Contrast with this the resources of modern therapeutics, with its range of antitoxins and bacterial products and its growing list of new synthetic compounds discovered as the result of deliberate and organized search, for substances which shall be harmless to the infected patient in doses which kill or prevent the multiplication of the infecting organism—the new type of experimental therapeutics which Ehrlich termed "chemotherapy." But a few years ago, it might have been supposed that the relation between the bacterial constituents and the antibodies or natural antidotes, which the body itself produces to neutralize them, was of a complexity which put it beyond the reach of attack by the methods of structural chemistry. The position has been so changed, however, by the work of Landsteiner, of Avery and Heidelberger and of others, that it is hardly too much to say that a new and exactly chemical basis for these mysterious phenomena of immunity is even now being



built. Meanwhile, the synthetic production of artificial specific remedies for infection has, in the course of some twenty-five years, given us arsphenamine and other organic arsenical compounds such as tryparsamide; various derivatives of antimony; complex organic substances related to the dyestuffs on the one hand or to natural alkaloids on the other, and specifically effective against the trypanosomes of African sleeping sickness or against the parasite of malaria, still the most deadly enemy to human life and health, if we view the world's peoples as a whole. We may properly class these synthetic substances with the antitoxins and other anti-bacterial substances, as artificial and natural agents for the removal from the body of harmful invaders from without.

(2) A second principal factor in this change in therapeutic outlook may be found, I think, in the recognition of diseases due to the lack of substances normally present in the body, without which its normal functions and the normal development of its organs and tissues can not proceed. These substances, required in quantities which, in some cases, seem almost fantastically small, but none the less essential for healthy function, are of two kinds.

(a) The body has its own factories, in the glands of internal secretion, for the wide variety of principles grouped together as the hormones; and modern therapeutics can show no triumphs more brilliant than those which have followed the discovery of methods of preparing a number of these in a state of sufficient purity to enable them, by artificial administration, to correct an abnormal deficiency. We have spoken already of the first example in the treatment of myxoedema by thyroid gland substance, and of the dramatically successful correction of the diabetic defect by insulin. The thyroid treatment had involved few technical problems of preparation or administration, since the raw gland substance, given by the mouth in small doses, was already effective. In the case of insulin, the existence of such a pancreatic hormone, and even its origin from the islets of Langerhans, had been very probable for many years; but all attempts to prepare it and to apply it in treatment had failed. The influence of Banting and Best's great achievement, in showing that insulin could be obtained in stable solution and applied effectively by injection, went far beyond their immediate problem, in awakening new hope and initiative with regard to other hormones, which had appeared to be equally elusive. Tetany, Addison's disease, pernicious anemia have now all been brought within the range of specific treatment, by artificial supply of the defective hormones from the parathyroid glands, from the suprarenal cortex and from the stomach and the liver, by the brilliant work of Collip, of Swingle, Hartmann and their respective coworkers, and of Minot,

Castle and their colleagues. Who can doubt that preparations from these glands are destined to acquire an increasing range and success of application, as the methods for purifying and stabilizing their subtle principles are progressively improved, and as clinical science, thus able to apply them, recognizes more clearly the conditions due to partial defects of their natural supply? I can not take time for more than a mere mention of the new vistas of knowledge which are being opened by the study of the complex interplay of the series of hormones controlling the physiological cycles of sexual activity and reproduction or by the daily unfolding of the multifarious activities of the hormones formed by one part only, the so-called anterior lobe, of the pituitary body, tucked away in a little bony recess at the base of the brain. Somebody has already bestowed on this tiny organ the picturesque title of "the conductor of the endocrine orchestra." And, indeed, there is no sign yet of any end to the revelation of new directions in which its hormones control the activities of other glands and their output of other hormones. Methods for obtaining in separate solutions the apparently different principles by which this pituitary lobe presides over normal growth and over the activities of the sex glands, and by which it acts in some kind of balancing antagonism to insulin, are already beginning to appear. It can hardly be doubted that some of them, with advances in the technique of their separation, are destined to play important rôles in practical therapeutics.

Let us note, further, for encouragement, how many of the hormones have already been prepared in chemically pure condition. In the case of epinephrine and thyroxine chemistry has gone much further than isolation; not only is their structure exactly known, but they can be prepared by artificial synthesis. In the case of one of the female sex-hormones the structure is already known with practical certainty, and synthetic production may be anticipated with some confidence. Insulin has been obtained by Professor Abel, and by others who have followed his lead, in crystalline form; though its complex, protein-like nature affords less hope for the elucidation of its structure. And now, only in the past few weeks, comes news that Dr. Kendall, of the Mayo Research Institute, who first obtained pure thyroxine, has succeeded in preparing what appear to be pure crystals of the elusive hormone of the suprarenal cortex.

(b) Then there is the second class of specifically acting substances, necessary like the hormones for healthy function and growth, but obtained by the body mainly from the food, and known to all the world as "vitamins." The story of these, of their successive recognition, still not completed, by the protective action of each against a different well-known

disease of deficiency, such as scurvy, rickets, beri-beri, pellagra, provides, like the story of the hormones, one of the romances of recent medical research. It is related of Jaques Cartier and his expedition, when they landed in Canada four hundred years ago, that, being attacked by scurvy, they learned from the native Indians to cure the condition with an infusion of the fresh sprouting tips of a species of fir tree. Nobody can guess how long the Canadian Indians had possessed this life-saving knowledge, just as those of the South American Continent knew of the value of cinchona bark in fevers and of ipecacuanha in dysentery. This method of treating scurvy, however, passed out of the white man's memory for yet another two centuries. A more extended knowledge of the relation of scurvy to lack of what is now called Vitamin C, and even of the kinds of food containing the missing factor, again became available in the eighteenth century, from the experience of Scandinavian and British sailors and explorers. Captain Cook's voyages of discovery in the good ship *Endeavour*, to the islands of the Pacific, to New Zealand and Australia, owed their success largely to the scientific measures which he took to protect his crews from disease and particularly from scurvy. I take some satisfaction in noting that the Royal Society of London, when giving to James Cook the Copley Medal, the highest honor at their disposal, based the award, not on his great geographical discoveries, but on his improvement of methods for preventing disease among sailors. Yet we had to wait till the present century for a study of diseases due to such qualitative defects of diet, as an important branch of medical research, and the systematic, experimental study of such defects, by the use of artificially compounded diets, began only a little over twenty years ago. Six at least of these vitamins are already known as separate entities, with the special disease or functional defect, produced by the absence of each from the diet. The chemical nature of three or possibly four of them has been clearly established; two at least of them, Vitamins C and D, have been artificially prepared in a state of complete purity. Here again, a whole vista of new possibilities has opened, for the scientific treatment and prevention of diseases which, but a few years ago, presented a baffling series of problems to medical practice. Some applications have become, in a literal sense, household words. When a few years ago my colleagues at the National Institute for Medical Research, in London, obtained a pure, crystalline Vitamin D, and gave it the chemical name Calciferol, it was desirable to show, by actual trial in the clinic, that this intensely active substance had a curative action on rickets in children, as well as on experimental rickets in rats. London was searched in vain for suitable cases of rickets, in which

the good mothers had not already begun treatment with cod-liver oil, before presenting the little patients for examination; and we had to go further afield, to an area of extreme industrial depression, before the action of Calciferol could be demonstrated on cases not previously treated. Again in the case of the vitamins, it seems probable that scientific application in medicine is only just becoming a possibility, now that their separate preparation enables the action of each to be individually studied, and the results of its deficiency to be more clearly recognized and disentangled.

It would be possible to regard this remarkable change in therapeutic outlook and method simply as one phase in the general scientific development which has transformed a whole range of human activities in a generation. If we look, however, for a particular rather than a general cause, I think we shall find it in the rapidity with which chemical knowledge and ideas have, in this same period, permeated the whole of medical and biological science. Forty years ago, though chemical research in the domains of physiology and pathology had representatives of high distinction, the orthodox chemist was often ready to ignore their activities, or to rank them as a pretentious type of cookery. To-day biochemistry has long taken rank among the great divisions of science, and its influence penetrates the whole range of the medical and biological sciences, while organic chemistry itself is showing a welcome tendency to recover its original objective, in studying the products and processes of living organisms. Pathology, immunology, physiology, have come more and more under the discipline and the stimulus of chemical ideas; zoology and botany concern themselves more and more with function, in terms of chemical changes and chemical stimuli; and the study of nutrition has ceased to think of diet only in terms of the main builders of the body's fabric and the direct sources of its energy, and has devoted itself with increasing enthusiasm and success to identifying the minute qualitative factors, specifically influencing metabolism and function, such as the vitamins and the minor mineral constituents. The remarkable development in the scope and aims of chemical therapeutics has been a natural concomitant of this rapid chemical orientation of medical science.

(It may be of interest to take a brief glance at some of the current expansion of this general tendency in fields of investigation which lie as yet outside the range of practical application in therapeutics.)

A few years ago it was customary to speak of the body as coordinating its activities by means of two forms of communication—by messages transmitted by physical changes through the nerves and by chemical messengers or hormones carried by the blood. These



have been picturesquely described and contrasted as the telegraph and postal services of the body. Apart from the true hormones certain other highly active chemical substances have become known, widely distributed in the tissues, and taking part in local regulation, of the blood-supply especially. It has also been known for some years that the nerves belonging to a certain system, which controls the involuntary activities of the viscera, the heart and the blood vessels, do not exercise this control by a direct transmission of the physical impulses passing along them to the organs in which they end, but by liberating potent chemical agents, by the action of which the effect of the nerve impulses is transmitted. Two such agents were recognized, transmitting the largely antagonistic effects of different groups of these nerves. One of them has been almost certainly identified as acetylcholine—a substance of which the intense activity was first recognized by Professor Reid Hunt nearly thirty years ago, and in which I also became interested at an early stage, long before we had any reason to believe that it occurred in the body or had any important natural function. Loewi, who gave the first clear demonstration of this chemical transmission of nervous effects, recognized the close similarity to acetylcholine of the substance liberated in the frog's heart by impulses in the vagus nerve; and the evidence for this identification grows almost every week. The other substance, which has recently been studied especially by Professor Cannon, transmits effects of nerves of the so-called sympathetic system; and its actions and such of its chemical properties as it has yet been possible to test suggest a close similarity to epinephrine or adrenaline, as long known as a hormone from part of the suprarenal gland. To take one example, the rate and force of the heart beat are controlled by impulses reaching it through two different nerves, those from the vagus nerve making it slower and weaker, while those from its sympathetic nerve make it quicker and stronger. It can now be stated definitely that the vagus impulses produce their effect by liberating acetylcholine, and that the sympathetic impulses produce theirs by liberating something like adrenaline, among the fibers of the muscular wall of the heart.

So far the main lines of the picture have been clear for some years; but during the year now ending it has undergone a rapid extension and development. Acetylcholine, in particular, is acquiring an importance in the physiology of the nervous system far beyond any that could have been predicted. We already have evidence that, at every point in a nerve ganglion where a nerve fiber ends in contact with a nerve cell, transmission of the effect of an impulse from one to the other is effected by liberation of a tiny charge of acetylcholine. We can even estimate

the order of the amount—of the weight of acetylcholine used to transmit the effect of a single nerve impulse to a single ganglion cell; but, if I give the weight in grams, I shall have to ask you to imagine a row of 20 noughts to the right of the decimal point before you reach a significant figure ( $10^{-21}$  gram). We have further evidence, less complete but highly suggestive, that every ordinary motor nerve impulse, to a fiber of our voluntary muscles, similarly produces its effect by liberating a little charge of acetylcholine in contact with the receptive plate of the muscle fiber, thus stimulating it to contraction. As I speak to you, I have every reason to suppose that the muscle fibers of my tongue and my jaws are being activated by innumerable little charges of acetylcholine, fired at them, as it were, from the endings of the nerve fibers.

For the whole of the peripheral nervous system, then, we seem to be in sight of knowledge enabling us to describe the transmission of effects, from nerve fibers to receptive cells, in terms of precise chemistry. And the vast and complex problem of the central nervous system still remains. It will be strange, indeed, if knowledge of this kind, expanding just now with such unexpected rapidity, does not eventually have some effect, if only an indirect one, on practical therapeutics.

Let us glance at an entirely different field of research. We have spoken of the pure crystalline Vitamin D, a sterol derivative which my colleagues have called Calciferol, and of the isolation of pure hormones concerned with the control of certain sexual functions. At least two of these have been crystallized and studied in pure condition, one concerned with female function, the other with the maintenance of the general characteristics of the male; and the general lines of structure of these substances have been established, so that it is not unlikely that one or the other may at any time be produced synthetically by some ingenious chemist. Perhaps it is not altogether surprising to learn that these sex hormones appear to be closely related compounds, differing from one another in detail rather than in general plan, though we are very far from understanding how so small differences of structure can produce so large a difference in physiological character. In the pattern of both we can trace again a central structural arrangement which, in the last few years, has been recognized as common to the group of the sterols, for long regarded as peculiarly inert constituents of the body. And now, within a few years, we find related to them, on the one hand, the vitamin D, on the other these sex hormones, all of them substances of intense physiological activity, but producing effects of entirely different kinds—surely a relationship which is sufficiently surprising. Yet there is

another even less to be expected. Habitual contact of the skin with tar has long been known to cause a liability to superficial cancer; and the condition can be produced experimentally in animals by frequent tar painting. Dr. Kennaway and his coworkers in London have for years been engaged in the difficult quest for the constituents of tars which produce this effect. And when at length they succeed, the substances they find have again a type of structure suggesting the central nucleus of the sterols, linking them with sex-hormones on the one hand and Vitamin D on the other. Induction of cancer with prolonged application to the skin, prevention and cure of rickets, provocation of sexual function and development—here is a curious assortment of activities to be linked by a central chemical structure, common to the substances producing them, and to the inert sterols as well. Nor is the community merely the theoretical one of chemical structure. The specific activity characterizing one or another of these, when it is given in tiny fractions of a milligram, may apparently be shown by the others when given in relatively large amounts. Thus, we have evidence that a substance which, when painted on the skin, causes a cancerous growth to appear, will also cause a capon to change its plumage for that of a normal hen, when injected in a suitable dose; while the same carcinogenic substance, or even the pure Vitamin D, if injected in relatively large amounts into female rats, will initiate a cycle of sexual activity. The chemical approach is leading us to some curious associations.

If we follow the story of this chemical induction of malignant growths a stage further, it leads us to an association still stranger and more mysterious. Years ago Rous of the Rockefeller Institute described the first of a series of malignant tumors in fowls, which had the property that its filtered juice, free from all cells and visible organisms, would cause a similar tumor to form in another fowl into which it was injected. A number of such tumors have since been described. And now, quite recently, comes the news that injection of some of these tar products into a chicken will cause a tumor to be found, and that a filtered extract from this tumor will reproduce its growth in other chickens, from which it can again be passed by filtrates in apparently endless propagation. Now the filtrates of these tumors have all the properties of living infective agents, not of chemical irritants. In a number of different ways they are allied to the viruses, the study of which, as the causes of many of the most important infective diseases, has progressed so rapidly in recent years. The study of the visible bacteria had left, as the great outstanding problem of infective pathology, these infections transmitted by materials in which no organisms could be cultivated or seen—smallpox, infantile paralysis,

measles, chicken-pox, mumps, yellow fever, influenza, the common cold, dog distemper, foot and mouth disease, and many more. Recent work, on both sides of the Atlantic, seems in the case of some of them, such as psittacosis and vaccinia, to have succeeded in demonstrating bodies like extremely minute organisms, so small that they were beyond the range of the microscopic methods previously available. There is a whole series, however, with infective particles of diminishing size until, as in the case of the virus of foot and mouth disease, they approach the dimensions of protein molecules in solution. They are not chemical agents in the ordinary sense, but it is difficult to picture them as organisms. The agents transmitting bird tumors fit into this series in many of their properties. Are we to picture them as lying in wait in the normal tissues, for some failure of their resistance, such as the tar substance might produce, to give them a foothold? Or does the chemical irritant produce some perversion of metabolism which starts the cell on its malignant career, the perversion being transmitted to the direct offspring of its cleavage, or even to normal cells by contamination with its juices. That is a statement, with the crudest brevity, of what appears to be the central problem, common to the study of the malignant tumors and of many of the infections due to acknowledged viruses.

We have turned aside for a hurried glance at the course of medical research at certain points where it is advancing freely into the unknown, where therapeutic application must probably wait till the fundamental structure of knowledge has been built and where hope for the future is more justified than action in the present. Our earlier survey, however, of the fields where therapeutic practice has been able to follow the expansion of knowledge more closely, presented us with a sufficiently imposing list of new types of scientific remedies—antitoxic sera, bacterial vaccines and antigens; artificial chemical antagonists to different infections; hormones which the healthy body makes in its own glandular laboratories; vitamins which it obtains ready made, or as raw materials for its own further elaboration, from natural, unsophisticated foods. We have made no mention as yet of the newer symptomatic remedies, the array of new substances synthesized in the laboratory or extracted from natural sources, for the relief of pain or the artificial stimulation of some flagging natural function. And what do all these new developments mean for pharmacy? They have but little relation to the art of the individual pharmacist whom our fathers knew, compounding his pills and potions among the jars and bottles of the dispensary. We must resign ourselves, I fear, here, as in other spheres of human activity, to the loss of an individual art in exchange for scientifically organized production.



Pharmacy, indeed, to meet these novel, various and expanding demands of modern therapeutics, has to become one of the most highly organized departments of scientific manufacture, covering an extraordinary range of expert knowledge and equipment. It now needs stables and pastures; incubation rooms for the large-scale culture of a wide variety of bacteria, and sterile rooms for manipulation of the products; chemical plant adapted to the difficult synthesis of complex and delicate compounds, or to the chemical and physical separation and purification of unstable natural principles, from animal organs only obtainable in adequate quantity and freshness by the cooperation of highly organized abattoirs. But there is a much more fundamental requirement. It is not organization, however perfect; it is not expenditure, however lavish, on manufacturing equipment; it is not even the services of a staff of highly qualified experts for the routine conduct and control of manufacturing operations, which will enable a pharmaceutical enterprise to meet the changing and expanding needs of modern therapeutic practise. It can not hope to do this, unless its activities respond to the stimulus and submit to the guidance of continuous and progressive research. And when I speak of research, it will be understood that I do not mean merely experiment directed to improving the technical methods of manufacture or the control of its products, though there is need and scope for work of high scientific quality in these directions. I mean research undertaken in a spirit of free inquiry, often with no immediate practical aim, or any probable result, other than the increase of fundamental knowledge. American industry has a noble record of the direct support of such fundamental research, and Dr. Langmuir's presence provides this occasion with a direct example and representative of this enlightened

policy. Eli Lilly and Company, also, have claim to high rank among the industrial organizations which have supported scientific research for its own sake. Numerous laboratories in this and, indeed, in other countries, have reason to be grateful for their generous and well-directed aid. As for their support of research within their own organization, I recently visited the Marine Laboratory at Woods Hole, and there saw Dr. Clowes and some of his staff, who had been working through the summer on problems of fundamental biology, in happy association with distinguished academic workers in the same field; and I brought away with me the conviction that there was no need here to urge on an enlightened directorate the claims of research having no immediate or visible relation to its business, but of immense value in keeping alive the scientific initiative and mental enterprise of those who also serve its interests more directly, and in helping them to establish and to retain their proper rank in the great scientific fellowship. It is because we know that Mr. Lilly and his co-directors, while free and generous in their support of medical and biological research in many laboratories and in many countries, have had the wisdom to give to their own scientific coworkers a wide freedom in the scientific field, and have known how to value the spirit which it engenders, that we take part with such pleasure in the inauguration to-day of these splendid research laboratories. We do so with high hopes for the use which Dr. Clowes and his distinguished staff of collaborators will be able to make of this greater opportunity, for their own advancement in the great commonwealth of research, for the advancement of the great and progressive industry which has provided the opportunity, and, above all, for the advancement of medical science in the interest of all mankind.

## PROGRESS IN DEVELOPMENT OF THE U. S. WEATHER SERVICE IN LINE WITH THE RECOMMENDATIONS OF THE SCI- ENCE ADVISORY BOARD

By WILLIS RAY GREGG

CHIEF OF THE UNITED STATES WEATHER BUREAU

THE Science Advisory Board, which acts under the jurisdiction of the National Academy of Sciences and the National Research Council, was created by order of President Roosevelt on July 31, 1933. This board was given authority "to appoint committees to deal with specific problems in the various departments." One of the first committees so appointed was the "Special committee on the Weather Bureau." Its

members are: Robert A. Millikan, director, Norman Bridge Laboratory of Physics, and chairman of the Executive Council, California Institute of Technology, Pasadena, Calif., *chairman*; Isaiah Bowman, chairman, National Research Council, and director, American Geographical Society, New York City; Karl T. Compton, president, Massachusetts Institute of Technology, Cambridge, Mass.; Charles D. Reed,

senior meteorologist in charge, Weather Bureau Section Center, Des Moines, Iowa.

This committee submitted a report, based on a very thorough inquiry and study, in December, 1933. The report contains a number of recommendations, the two most important being: (1) An extension of the air-mass analysis method of forecasting; (2) Consolidation of weather and communication service under the Weather Bureau.

Naturally, in so brief a period as has elapsed since the submission of this report, it has been possible only to make a beginning toward putting these and other recommendations into effect. Furthermore, the special committee itself has, in its report, sounded a note of caution against too precipitate a change from the old, well-established and quite efficient methods of forecasting to the newer, so-called "Air Mass Analysis" method. It was suggested that the transition might well take place in the course of something like five years. This present statement must therefore be confined largely to an expression of what we *hope* to accomplish, together with an outline of such portions of the program as it may be possible to undertake in the very near future.

(1) *Air Mass Analysis*: At the outset it should be emphasized that there is nothing particularly new in the "Air Mass Analysis" concept of forecasting. It has been quite fully understood for many years, but its effective application has not been possible, because it requires a greater wealth of observational material than has heretofore been available. Briefly, air mass analysis consists of a detailed study of masses of air of decidedly different structure as to temperature, moisture and wind that meet along an irregular line variously referred to as a "discontinuity line," "polar front," "wind shift," etc. These masses of air, cold and dry from polar regions, warm and humid from equatorial, do not readily mix but tend to preserve their individual identities, the warm, moist air being forced to rise above and flow over the denser cold air, with resulting condensation and precipitation and other attendant phenomena which give us most of the stormy weather characteristic of temperate latitudes.

It will be seen at once that the chief requisite for such analysis is more detailed information concerning the structure of these conflicting masses of air. Accordingly, the first step in carrying out the recommendations of the Science Advisory Board was the formation of an interdepartmental committee to determine what could be done along this line through cooperation. It is gratifying to be able to report that, as a result of this committee's recommendations which have been approved by the secretaries of the departments concerned, there are, beginning on July 1, 1934, some 20 stations at which regular daily airplane

flights are made to a height of about 5 kilometers. These stations, comprising approximately an equal number to be operated by the Weather Bureau, the War Department and the Navy Department, are quite well distributed over the country. The flights are made at essentially the same time at all of them. In addition, at certain other stations and also on 7 naval ships occasional flights are made during daylight hours, and the data from these flights will be of considerable value, even though not representing conditions at the times of the regular daily flights.

Thus, on July 1, a very definite beginning was made in securing data necessary for the extension of air mass analysis in forecasting. Twenty stations will not be sufficient, but they at least mark a definite step toward the ultimate goal.

(2) *Communication Service*: With regard to the second major recommendation of the Science Advisory Board, that of consolidating weather and communication service under the Weather Bureau, it can only be said at this time that the matter is receiving thorough and careful study by an interdepartmental committee. No definite report on this matter can yet be made.

*Other recommendations*: Several of the recommendations of the Science Advisory Board are designed to assist in carrying out the one concerning the adoption of air mass analysis, such, for example, as those for the decentralization of the general forecast service, special training of qualified personnel, improved exposures of instrumental equipment, an increase from two to four observations daily and more detailed information in those observations. Concerning these recommendations it can be stated that a program for putting them into effect has been outlined in detail, including arrangements for co-operation with other departments, and including also estimates of additional personnel, funds and other facilities that will be required for the whole program. Moreover, a beginning has already been made on some parts of the program. For example, in a few cases the observational work has been transferred from high office buildings in cities to nearby airports where excellent conditions of exposure are available. This is now a part of the regular policy of the Weather Bureau. Putting it into effect on a large scale will, however, require some time, since in the case of the larger cities it will still be necessary to continue observations in the cities themselves, for local use of engineers and in court cases. In other words, duplicate records will be necessary, and this will require additional funds. The program will, however, be carried out as rapidly as possible.

Action has been taken to set up a Civil Service examination, looking to the appointment of a few



men of advanced training and experience in air mass analysis. It is expected that these appointments will be made in the early autumn.

Much closer contact between central office and field officials and more frequent inspections of service generally are a part of the program for this coming fiscal year. It will not be possible, however, to do all that should be done along this line until more funds are provided. It should not be forgotten that the bureau's appropriation has suffered a reduction of some \$800,000 during the past two years, and that much of the service then given up should be restored. Adding new features now, therefore, while still working on a greatly reduced budget is not a particularly easy task.

In conclusion, it is desired to express the very great pleasure with which I have noted the fine spirit of cooperation on the part of officials of other bureaus and departments whose services are closely related to, or dependent on, that of the Weather Bureau; also, the enthusiasm of our own personnel in connection with the new program and their eagerness in participating in it. Then, too, the support of outside organizations and individuals is most encouraging. In fact, as I see it, there has perhaps never been a period more potential of promise for real advances in meteorology than the present. The marvelous developments in communications, particularly in radio, provide information regarding conditions in regions that have heretofore been inaccessible, thus vastly extending our meteorological horizon. The successful design and construction of fast-climbing

airplanes have resulted in giving us detailed data in the vertical. Improvements in instrumental apparatus provide more accurate data. Finally, the organization of strong meteorological courses at some of our leading educational institutions can not fail to yield large returns, both in research and its applications and in highly trained personnel.

I imagine that the most optimistic period in the entire history of meteorology was that when the first synoptic weather maps were drawn. Those who studied these maps and noted the changes taking place from day to day must have seen in them a promise of complete solution of the problems of forecasting. This optimism was not realized in full, yet most of the success that we have since had in weather forecasting had its origin in what these early pioneers saw in the synoptic weather maps.

We now likewise view the future with optimism. This optimism may not be fully realized, just as the other was not, but with the aid of the working tools to which I have referred, such as the extension of observations in the horizontal and vertical through the media of radio and the airplane, respectively, together with improvements in instrumental design and exposure and fundamental researches that are now in progress or in prospect, there seems to be little doubt that very real improvements will be realized in the accuracy of forecasts, in the period covered by them, and in the integrity and representativeness of the great body of statistical data that the Weather Bureau is accumulating through its far-flung network of observational stations.

## SCIENTIFIC EVENTS

### RESTRICTION OF THE NUMBER OF MEDICAL STUDENTS IN FRANCE

ACCORDING to a correspondent of the *Journal* of the American Medical Association, Dr. Georges Portmann, professor of otorhinolaryngology at the Faculté de médecine de Bordeaux, elected senator last year, has introduced a bill designed to limit the number of students to be admitted to the facultés de médecine. In 1930 the dean of the Faculté de médecine de Paris and the general secretary of the Confédération des médecins de France called attention to the deplorable situation in a circular letter addressed to the parents of pupils in the lycées, urging them to enlighten their children in regard to the future prospects of those who, under present conditions, take up the study of medicine. The number of physicians in France has increased from 16,815 in 1900 to 27,500 in 1928, whereas in this period the population has increased only two million. In spite of warnings, the situation

has grown steadily worse. The number of students enrolled in the French medical schools has risen from 8,182 in 1929 to 9,780 in 1930, 9,842 in 1931, 10,242 in 1932 and 10,338 in 1933. The number of government diplomas issued to doctors of medicine by all the facultés de médecine was 1,076 in 1930, 1,102 in 1931 and 1,397 in 1932. But these figures correspond to the number of students enrolled five or six years previously. It is evident that in five years the number of graduates will be much greater. Overcrowding of the profession is reported from other countries. In Germany the Hitler government has recently decided that the number of medical students, which was 25,000 in 1933, shall be reduced to 15,000 in 1934. The bill proposed by Senator Portmann is not so rigid. It does not fix any maximum. It provides that the total number of medical students to be matriculated be fixed each year, according to the number of civil, army, naval and colonial physicians required, by a commis-

sion composed of the minister of public instruction, the minister of public health, the Confédération des syndicats médicaux, and the ministers of war, the navy department and the colonies. The selection would be made in two stages, the first at the end of the preparatory studies leading to the premedical diploma in physics, chemistry and biology, which affords entrance to the facultés de médecine, and the second after completion of the first year of study in the facultés de médecine. Only the number of holders of the premedical diplomas, as fixed by the ministerial commission, plus 50 per cent., would be admitted to the facultés de médecine, and this additional 50 per cent. would be eliminated at the end of the first year of medical study. This regulation would concern only candidates for the government diploma, which grants the right to practice medicine in France (and in Rumania). As to the students enrolled for a university diploma, a degree much sought by foreigners, no limitation will be placed on their number; but the later transformation of a university diploma into a state diploma will be made more difficult and will be brought into harmony with the number of state diplomas fixed by the projected legislation.

#### THE PROPOSED MIGRATORY BIRD RESERVE IN THE NORTHERN SAND HILLS OF NEBRASKA

ACCORDING to the New York *Sun*, a migratory bird reserve will be laid out in the northern sand hills of Nebraska by the Federal Government at the cost of a million dollars, the object being to provide a resting and nesting place for wild ducks, wild geese and other birds migrating between the Mexican gulf district and western Canada. One of the artificial lakes which will be constructed will cover more than 30,000 acres.

The sand hills comprise a strip of land, about one hundred miles wide, running from South Dakota southward almost to the Platte River. Very little vegetation grows except in the small valleys between the hills, and even in these valleys grass is practically all that is produced. There are many small lakes of cool, clear, pure water, caused by filtration of rain through the sand. A number of these small lakes are to be included in the federal game reserve, and the government agents have concluded an arrangement with the Nebraska State Game Commission under the terms of which state laws on fishing will not be interfered with when the property becomes a part of the federal reserve.

Nebraska is the stopping point for the birds between their winter feeding grounds along the Gulf and their summer breeding grounds in western Canada. Nebraska has more miles of rivers and flowing streams than any of the forty-eight states of the

Union, and in both spring and fall these streams are simply covered with the migrating fowl.

The 30,000-acre lake will be formed by damming the Snake River, which passes through the reserve from west to east. This is not the Snake River of Idaho and Oregon, but a different and a smaller stream which flows into the Niobrara River. The proposed reserve is mostly in Cherry County, Nebraska. The land is not very valuable. One ranch of about 10,000 acres is being taken over by the government at \$8 an acre. This ranch will be entirely covered by water when the big dam is completed. Other lands are worth \$4 and \$5 an acre.

The shortage of water in the last few years has lowered the water table in this district and many of the lakes are now but a fraction of their usual size, while the marshes are now pretty well dry. Water from the Snake River dam will be turned into these smaller lakes by connecting canals, and they, as well as the marshes, will be brought back to normal.

J. C. Salyer, director of the migratory waterfowl program of the U. S. Biological Survey, is at the head of the government staff working on the project. Other government officials on the work are the chief agricultural engineer, the chief acquisition officer, the principal duck food biologist and the program's coordinator for Nebraska and South Dakota.

#### RESEARCH IN DENTAL MEDICINE AT HARVARD UNIVERSITY

SEVEN research men in the Faculty of Arts and Sciences, the Medical School and the Dental School of Harvard University have been appointed by President James B. Conant members of a University Committee on Research in Dental Medicine.

In recognition of the fact that modern dental research is intimately bound up with and dependent upon research and expert knowledge in the fields of chemistry, biology and medicine, the committee has been given general supervision over research in the Dental School. Its province will be trifold: to promote important dental research; to act as a clearing house for such of that research as is important to other fields; and to provide official contacts through which the Dental School can readily get assistance for its research problems that overlap the other departments.

The committee consists of Elmer P. Kohler, professor of chemistry; Alfred C. Redfield, professor of physiology and director of the Biological Laboratories; Simeon B. Wolbach, Shattuck professor of pathological anatomy, and consulting pathologist to the Cancer Commission of Harvard University; Walter B. Cannon, George Higginson professor of physiology; Percy R. Howe, Thomas Alexander Forsyth



professor of dental science and instructor in pathology, Harvard Medical School; Lawrence W. Baker, professor of orthodontia, and Dr. George P. Matthews, instructor in anatomy. Dean Leroy M. S. Miner, of the Dental School, will serve as a member *ex-officio* of the committee.

The first project sponsored by the committee will be an elaboration of some research work in the effects of nutrition on teeth and their supporting structures, which has been carried on by Professor Howe, collaborating with Professor Wolbach.

The particular problem is as follows, in the general field of vitamin deficiency studies:

1. Extension of studies now in progress on the mode of action of Vitamin C or ascorbic acid to include: (a) testing, with scorbutic guinea-pigs, the activity of products intermediate in the synthesis of ascorbic acid from xylose; (b) the preparation and testing of substances formed by systematic changes in the structure of ascorbic acid; (c) an investigation of the manner in which ascorbic acid is produced by animals which are not subject to scurvy.

2. The study of the effects of inorganic deficiencies and especially the substitution of various elements for calcium in the diet.

3. The study of intercellular materials as solvents in the living animal for diffusible materials introduced into the blood stream at a rate faster than elimination can take place. There is much evidence that sugars diffuse into collagen to a point of equilibrium with the accumulation in the blood stream so that the studies should begin with sugars. It is possible that sugars may play a rôle in calcification of tissues. In any event, an attempt will be made to study calcified tissues, teeth and bone. It is to be anticipated that progress will be slow as the techniques required will have to be worked out.

For this work the committee has received a Milton Fund grant of \$8,000 for the year 1934-35. It will be under the immediate supervision of Professors Howe, Wolbach and Kohler of the committee.

It is proposed to obtain the assistance of a research organic chemist, who will develop the chemical aspects of the problem, under the guidance of Professor Kohler. Dr. Wolbach will supervise the work in the pathological field, while Dr. Howe will continue his general nutritional experiments.

Other projects now in progress deal with dental caries, the most prevalent of all diseases, and with studies of the growth and development of the jaws and teeth.

Since the naming of the Thomas A. Forsyth chair of dental science in 1925, there has been a liaison between research activities of the Dental School and the pathological department of the Medical School. But until the present step there has been no general, official cooperation between the research staffs of the University and of the Dental School.

## RECENT DEATHS

DR. JOSEPH FRANK MCGREGORY, professor emeritus of chemistry at Colgate University since 1929, formerly head of the department since its formation in 1883, died on October 14 of injuries received in an automobile accident. He was seventy-nine years old.

DR. CARL LEOPOLD VON ENDE, head of the department of chemistry at the University of Idaho since 1908, died on October 9 at the age of sixty-four years.

HAROLD DEWOLFE HATFIELD, professor of industrial engineering and head of the department of civil engineering at Rutgers University, died on October 13 at the age of forty-six years.

DR. STUART CROASDALE, mining engineer and metallurgist, of Denver, Colorado, died on October 1 at the age of sixty-eight years.

SIR ARTHUR SCHUSTER, professor of physics at the University of Manchester from 1888 to 1907, secretary of the Royal Society from 1912 to 1920 and foreign secretary from 1920 to 1924, secretary of the International Research Council from 1919 to 1928, died on October 14. He was eighty-three years old.

DR. ROBERT FRANCIS SCHARFF, late Keeper of the Natural History Collections, National Museum, Dublin, and secretary of the Royal Zoological Society of Ireland, died on September 27 at the age of seventy-six years. He wrote on the origin and history of the European fauna, the fauna and exploration of caves in Ireland, the Atlantis problem and the distribution and origin of life in America.

PROFESSOR SIR EDGEWORTH DAVID died at Sydney, Australia, on August 28 at the age of seventy-six years. A correspondent writes: "His death will be a great blow to many of his friends in this country and throughout the world. Sir David was the Antarctic explorer who led the expedition to the South Magnetic Pole; he was in charge of the successful Funafuti boring of the Royal Society to determine the origin of atolls; the teacher of almost every Australian geologist worthy of the name, and altogether one of the finest men that ever lived. He had been working since his retirement to complete his masterpiece, 'The Geology of Australia,' and I am happy to say that a letter which I have from him dated August 1 intimates that the book was finished, but that ill health due to wounds received during the war, where he was chief geologist of the Australian Corps, had been causing a great deal of suffering of late so that he feared his trip to England to place his book in the hands of publishers would perhaps have to be delayed until New Year's."

## SCIENTIFIC NOTES AND NEWS

At ceremonies held on the occasion of the opening of the new library at the University of Cambridge on October 22, the honorary degree of doctor of science will be conferred on Dr. Lawrence J. Henderson, professor of biochemistry at Harvard University, and on Dr. Karl Landsteiner, of the Rockefeller Institute for Medical Research.

A LIFE-SIZE bas-relief of Dr. Harvey Cushing, Moseley professor of surgery at the Harvard Medical School from 1912 to 1932 and now Sterling professor of neurology at Yale University, will be hung in the administration building. The presentation to the university has been made by friends, pupils and associates of Dr. Cushing, for whom a number of small bronze medal replicas have been struck. The artist is Paul Brodeur.

THE degree of doctor of humane letters was conferred on Professor Albert Einstein at the opening on October 8 of Yeshiva College, New York City. Dr. David Eugene Smith, emeritus professor of mathematics at Columbia University, presented Dr. Einstein for the degree, and Governor Herbert H. Lehman delivered the address of welcome, to which Dr. Einstein replied.

PRESENTATION to Dr. John Uri Lloyd, of Cincinnati, of the Procter International Award of the Philadelphia College of Pharmacy and Science, in the form of a gold watch, in recognition of his contributions to the sciences promoting health, was made on October 9.

SIR HENRY HALLETT DALE, director of the British National Institute for Medical Research and secretary of the Royal Society, sailed for England on October 13, after giving the principal address at the opening of the new laboratories of Eli Lilly and Company at Indianapolis.

DR. LAUDER WILLIAM JONES, who for the past five years has been associate director of the Natural Science Division for Europe of the Rockefeller Foundation, is resuming his research and teaching as professor of chemistry at Princeton University.

DR. COLLIER COBB, since 1893 professor of geology at the University of North Carolina, has been awarded one of the three Kenan emeritus professorships in the gift of the university.

PROFESSOR JAMES E. BOYD has resigned as chairman of the department of mechanics of the Ohio State University after serving for twenty-eight years. The resignation applies only to executive duties involved in the chairmanship. Professor Percy W. Ott has been designated his successor.

DR. ARTHUR E. RUARK has been appointed head

of the department of physics at the University of North Carolina.

LEWIS W. TAYLOR, assistant professor of poultry husbandry, at the University of California at Berkeley, has been appointed chief of the poultry department.

DR. LEIF VERNER, assistant horticulturist at the University of West Virginia Agricultural Experiment Farm, has been appointed professor of horticulture at the University of Idaho. Dr. Verner takes the place of Professor C. C. Vincent, who died on August 19, after serving for twenty-four years.

DR. A. RICHARD BLISS, JR., has been appointed to the professorship of pharmacology and to the newly created office of dean of pharmacy at Howard College, Birmingham, Ala.

CHESTER M. ALTER, who for the past two years has been research associate in geophysics at Harvard University, has become a member of the faculty of Boston University, where he will have charge of the courses in analytical chemistry.

DR. GABRIEL SZEGOE, professor of mathematics in the University of Königsberg and a representative of the German-Hungarian mathematical school, has joined the faculty of Washington University, St. Louis, where he will teach during the coming year.

DR. D. E. RUTHERFORD has been appointed lecturer in mathematics and applied mathematics in the United College at the University of St. Andrews.

*Industrial and Engineering Chemistry* states that Dr. Charles H. Herty, Jr., has been appointed a research engineer in the Development and Research Department of the Bethlehem Steel Company. Dr. Herty was formerly director of research of the mining and metallurgical advisory boards of the Carnegie Institute of Technology.

ALAN T. CHAPMAN, for the past two years a National Research Fellow in Chemistry at the Gates Chemical Laboratory, California Institute of Technology, has accepted a position as research chemist with the R. and H. Chemicals Department, E. I. du Pont de Nemours and Company, Inc., Niagara Falls, N. Y.

SIR HARRY ALEXANDER FANSHAW LINDSAY will succeed Lieutenant-General Sir William Furse, who retired from the post of director of the Imperial Institute, South Kensington, on September 30.

By an order of the Committee of the British Privy Council, made after consultation with the Medical Research Council and with the president of the Royal



Society, Dr. A. J. Clark, professor of materia medica at the University of Edinburgh, and Dr. J. C. G. Ledingham, director of the Lister Institute of Preventive Medicine and professor of bacteriology in the University of London, have been appointed members of the Medical Research Council, in succession to Sir Charles S. Sherrington and Dr J. A. Arkwright, who retired in rotation on September 30.

DR. MARIUS P. RASMUSSEN, professor of marketing in the College of Agriculture at Cornell University, is conducting surveys in various states for the Farm Credit Administration on the movement of agricultural commodities by truck, as a basis for a possible change in government methods of reporting crop movements.

B. D. MOSES, associate professor of agricultural engineering at the University of California, is making a study of engineering problems arising from the use of ethylene gas in maturing walnuts, in conjunction with the United States Department of Agriculture.

DR. LOWELL E. NOLAND, associate professor of zoology at the University of Wisconsin, is collecting and working up material for his forthcoming monograph on the Ciliates of the United States, at the Bass Biological Laboratory, Englewood, Florida.

THE General Education Board has made a grant allowing a year of study and research in the Galton Laboratory of the University of London to Dr. A. E. Brandt, assistant professor of mathematics in the Iowa State College. He will work under Dr. R. A. Fisher on the application of statistics to fundamental problems in biology.

PROFESSOR LEONARD A. MAYNARD, of Cornell University, recently returned from a six months' visit to China, where he made a study of the food consumption of Chinese farm families. The project of educating the Chinese farmer to improve his crops is being undertaken by the University of Nanking. For the last six years the College of Agriculture has been cooperating in this work by sending one professor to China each year. The University of Nanking has defrayed travel and maintenance expenses of the visiting professors and all expenses in connection with the plant breeding work at Nanking.

THE first Smith-Reed-Russell lecture at the School of Medicine of the George Washington University was given by Surgeon-General Robert U. Patterson on October 18.

DR. JAMES S. MCLESTER, professor of medicine at the University of Alabama and president-elect of the American Medical Association, delivered the annual Gorgas address before the La Fayette Guild Chapter

of the Gorgas Medical Society at the University of Alabama on October 3. His subject was the "Drifting Sands of Medical Practice." The occasion was in commemoration of the eightieth anniversary of the birth of William Crawford Gorgas.

THE fifty-second annual meeting of the American Ornithologists' Union will be held in Chicago, from October 22 to 26. Monday, October 22, will be occupied with business sessions which will be held at the headquarters in the Hotel Stevens. Tuesday, Wednesday and Thursday will be devoted to public sessions in the Field Museum of Natural History, beginning at 9:30 A. M. and 2 P. M., at which papers will be presented summarizing recent work in various phases of bird study. The annual dinner will be held on Wednesday evening at the Hotel Stevens, and on Friday members will visit the Zoological Gardens at Brookfield recently opened by the Chicago Zoological Society.

THE fifteenth annual meeting of the Mineralogical Society of America will be held at the University of Rochester, N. Y., on December 27, 28 and 29, in conjunction with the Geological Society of America. Headquarters and place of registration will be in the Chester Dewey Building. The first session will be held at 2 P. M. on Thursday, December 27. It is planned to publish in the December issue of the *Journal* of the society a preliminary list of the titles of the papers to be presented before the society at its annual meeting. In order to appear on the advance program, titles of papers should be in the hands of the secretary by November 10. The secretary will send an abstract blank, which should be filled out and returned, as all titles must be accompanied by abstracts before they can be accepted for the final program.

AT a meeting of the Section of Neurology and Psychiatry of the New York Academy of Medicine, on October 9, there was presented a symposium on acute anterior poliomyelitis, which included the following papers: "Pathogenesis," by Dr. Maurice Brody and Dr. Arthur R. Elvidge, of McGill University; "Immunization," by Dr. William H. Park; "Abortive Cases as Protective Agents against Epidemics," by Dr. John R. Paul and Dr. James D. Trask, of Yale University School of Medicine; "An Experimental Approach to the Problem of Resistance," by Dr. C. W. Jungeblut. Dr. John L. Rice, commissioner of health of New York City; Dr. Josephine Neal, Dr. Frederick Tilney, Dr. Bernard Sachs and Dr. George Draper took part in the discussion.

A CORRESPONDENT sends to SCIENCE the following description of the fall of a meteor given in *The News and Courier* of Charleston, S. C., for September 14. "A meteor that lit up the skies in this vicinity 'as

bright as day' and was reported sighted as far south as Jacksonville and as far north as Florence, flashed through space a few minutes after 1 o'clock this morning. The first report of the meteor came to *The News and Courier* from C. M. Dempsey, night watchman at the port terminals. Mr. Dempsey said that the daylight continued for at least five seconds. His report was followed quickly by a message from the Atlantic Coast Line railroad saying that radio operators all the way from Florence to Jacksonville had reported the meteor. Several other phone calls were received from persons in this section. Mr. Dempsey said also that

he had seen two smaller meteors a few minutes after 9 o'clock last night."

THE Connecticut Arboretum at Connecticut College was dedicated on October 6 with U. S. Senator Fred-eric C. Walcott as the principal speaker. The arboretum consists of about sixty acres of the Connecticut College property which has been set aside for the preservation and propagation of the native plant life of Connecticut. Planting in the area will be done under the direction of Dr. George S. Avery, Jr., professor of botany at the college and director of the arboretum.

## DISCUSSION

### BACKGROUND OF MATHEMATICS IN AMERICA

THE history of mathematics in America is greatly illuminated by the history of the coeval mathematics in Europe. For more than a hundred years after the discovery of America (1492) none of the English universities had established a chair of mathematics. The first such chair was founded at Gresham College, London, in 1596 and the second at Oxford in 1619. The first appointee to both of these chairs was H. Briggs (1556-1630), who is widely known in connection with tables of logarithms, and who has the singular distinction of holding in succession the two earliest chairs of mathematics that were founded in England. Cambridge University, England, did not establish a professorship of mathematics until 1662, more than a quarter of a century after Harvard University was founded (1636). The first appointee to this chair was I. Barrow, who resigned seven years later in favor of his pupil, I. Newton, who made this chair famous for all times.

The slowness with which mathematics was emphasized in the schools established by the early white settlers in our country is partly explained by the fact that these settlers left their native countries before mathematics was commonly regarded as an essential part of a liberal education. The pioneers who came to our land to explore and develop a new country were paralleled at home by the equally aggressive mathematical pioneers who entered into the then new and unexplored fields of analytic geometry and calculus. The fact that the latter pioneers did not mix with the former explains why no American contemporary of R. Descartes, I. Newton, G. W. Leibniz, the Bernoullis, A. L. Cauchy, L. Euler and J. L. Lagrange can be found who can be favorably compared with any of these from the standpoint of mathematical contributions. Just as in other countries, so in our country the development of mathematics did not prosper until positions were established which were filled by those selected on account of

proved ability and which afforded their incumbents leisure to develop these abilities.

Early American mathematics as derived from Europe was quite cosmopolitan, just as the white settlers in America came from various European countries. In view of the relatively great mathematical advances made in France shortly after the Revolutionary War and the aid rendered by France during this war to the colonies which later became the United States, it is natural that French mathematicians had a dominating influence on American mathematics at that time and that a relatively large number of French text-books were translated for use in American schools during the first half of the nineteenth century. During the second half of this century German mathematicians attracted most of our mathematical students who went abroad for further study and they continued to do so up to the beginning of the world war. The unexcelled opportunities afforded by some of our own universities are, however, now commonly recognized, but the background of American mathematics is still decidedly European, even if some of the useful recent extensions exhibit fruitful American cooperation.

The fact to be emphasized about American mathematics is that it is essentially a mathematics of cooperation with European mathematicians and has no decidedly distinctive features. It is true that in early times the applications to surveying, navigation and astronomy were especially stressed, but this had been done elsewhere in the early development of our subject and hence it did not give rise to a new type of mathematics. Nearly all the contributions towards the development of mathematics in our country are due to professors in our universities. Although Harvard is the oldest American university it was not the first to establish a chair of mathematics. Such a chair was first founded at William and Mary College which is next to Harvard in seniority (1693) and provided for such a chair in its charter, which seems to have been first filled in 1711 by the appointment of a man



named Le Fevre, about whom little is known. None of the professors of mathematics in our early universities can be compared favorably with the best of their contemporaries in Europe holding similar positions up to the latter half of the nineteenth century, when B. Peirce, of Harvard, began to make valuable contributions to the advancement of our subject.

G. A. MILLER

UNIVERSITY OF ILLINOIS

### SCIENTIFIC LITERATURE

PROFESSOR VISSCHER's article in *SCIENCE* of September 14 (p. 245) describes a difficult situation, but I think there are serious objections to his proposed remedy. I venture to call attention to a case in which it seems to me that the library difficulty has been fairly overcome. Economic entomology has in modern times developed to an enormous extent and has become exceedingly diversified. Works relating to it continually appear in many countries, in all sorts of languages, many for instance in Russian. If some agency would bring all these books and papers promptly to my desk on publication, I could not find time to read them, and in many cases, owing to the language, I could not read them at all. Many, perhaps most, are primarily intended for use in particular regions, or by particular classes of people, yet they usually contain something of broader interest. Now the Imperial Institute of Entomology, in London, produces monthly the *Review of Applied Entomology*, in two series, A. Agricultural, B. Medical and Veterinary. It is strictly up to date; thus I find the August, 1934, issue contains abstracts of articles received during June and July of the same year. The reviews or abstracts are sufficiently full to give an excellent idea of the work done, and usually include most of the matter of general interest. I have not rarely had the experience of reading an article, and not fully appreciating its significance until I read the abstract in the *Review*. In about two hours, each month, I am able to run over the whole field of current economic entomology, and note the matters which are of particular interest to me. Frequently I note discussions of broad biological interest, such as those on the carrying of insects by air currents, or those on the diverse forms of malaria mosquitoes. The cost is negligible; the price is to be raised next year, but even then it will be less than a dollar a month. The two prime features are (1) promptness and (2) well-written and sufficiently full reviews by people who know the subject.

When we consider how and why money is expended in this country, it seems ridiculous to complain about the cost of printing scientific papers. Institutions can send out costly expeditions, and yet declare they

can not afford to pay for printing the results of the work of their staff. One of the best known and most highly esteemed scientific explorers in this country told me that he found it comparatively easy to raise money for an expedition, almost impossible to get it for publication, which is after all the result and purpose of the expedition. The whole situation depends on a wrong mental attitude and not on any real lack of power to accomplish what ought to be done. The lamentable consequence is that competent men will not spend their best years doing work of a comprehensive or fundamental character, not knowing how or whether it can be printed. I recently heard the story of one of the best entomological works produced in this country during the present century. The author had to put up \$10,000 to get it published. Fortunately, the sales have been sufficient to repay the money, I presume without interest. But how many of us can afford to provide such a subsidy? The actual work on the book over many years brings of course no financial reward, nor was it expected to do so. Is it not conceivable that a more enlightened day will come when such an author will be considered a great public benefactor and will be relieved of all financial anxiety concerning publication?

Returning briefly to the problem of the reader and the library, what we especially need are good synopses which bring out the salient known facts and serve to guide the reader to the detailed literature. As examples of this type of work I think especially of two which have been published very lately. One is "The Classification of Insects: a Key to the Known Families of Insects and Other Terrestrial Arthropods," by C. T. Brues and A. L. Melander, published by the Museum of Comparative Zoology, Harvard, 1932. The other is "The Families and Genera of North American Diptera," by C. H. Curran, 1934. As time-savers and preventers of error, such works can hardly be overestimated, although, in the nature of things, they can not attain perfection. They enable the worker to review the field of his science and stimulate him to search for new facts which will add to or correct the record.

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### PHOTODYNAMIC ACTION OF METHYLENE BLUE ON PLANT VIRUSES

PERDRAU and Todd,<sup>1</sup> studying the photodynamic action of methylene blue on nine animal viruses and on several strains of bacteriophage, found that the viruses of vaccinia, herpes, fowl-plague, louping-ill, Borna disease, Fujinami's tumor and canine distemper, as they exist in filtrates or other fluids devoid of

<sup>1</sup> *Proc. Roy. Soc., B*, Vol. 112, pp. 277 to 287 and 288 to 297.

living cells, as well as several bacteriophages, were highly sensitive to the photodynamic action of methylene blue. When exposed to suitable illumination a concentration of 1 part in 100,000 of dye in contact with the virus inactivated each of these viruses within a few minutes. The viruses of foot-and-mouth disease and of infectious ectromelia were found to be more resistant but could be inactivated by increasing the intensity of the illumination.

Since no similar studies have been reported for plant viruses, the following experiments, details of which will be reported later, may be of interest.

In the main the technique of Perdrau and Todd was used for studying Wingard's ringspot, streak (single virus streak of tomato), Tobacco Virus 1 (Johnson) and Tobacco Virus 6 (Johnson)—also known as aucuba mosaic virus. Ten cc of the virus-dye mixtures at pH's of 5.8 to 6.0 were exposed in petri dishes to a 500 watt lamp at a distance of 26 inches. At various intervals 0.10 cc of the virus-dye mixtures were removed and used to inoculate test plants.

As judged by infectivity tests on tobacco and cucumber, ringspot virus was completely inactivated after two minutes' exposure. After 20 minutes' exposure the virus of streak was not inactivated, though the number of local lesions produced on *N. glutinosa* showed that the concentration had been slightly reduced. Tobacco Virus 1 and 6 showed no reduction in concentration, even after an exposure of one hour.

Tobacco Virus 6 (Johnson) was also exposed at pH's of 3.0, 7.0 and 8.0 to thionine, potassium indigo-disulfonate and phenol-indo-phenol. The virus concentration as evidenced by the number of local lesions produced on *N. glutinosa* showed no apparent reduction as a result of this treatment.

From these experiments it would seem that in general plant viruses are more resistant to the photodynamic action of dyes than are animal viruses or bacteriophage.

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## SCIENTIFIC BOOKS

### RELATIVITY, THERMODYNAMICS AND COSMOLOGY

*Relativity, Thermodynamics and Cosmology.* By RICHARD TOLMAN, Oxford at the Clarendon Press. 497 pp. 1934.

TOLMAN'S Buch ist eine zuverlässige, ausführliche und klare Darstellung des gesamten Inhaltes der speziellen und der allgemeinen Relativitätstheorie. Dabei hat sich der Verfasser mit scharfem, kritischen Sinn auf eine phänomenologische Darstellung beschränkt und die zahlreichen Versuche unberücksichtigt gelassen, den Zusammenhang zwischen Gravitation und elektromagnetischem Felde sowie die Struktur der Materie durch die Methoden der Relativitätstheorie aufzuhellen. Dies erscheint durchaus berechtigt, da keiner dieser voneinander grundsätzlich verschiedenen Versuche bisher zu irgendwie überzeugenden Ergebnissen geführt hat. Auch die Versuche einer relativistischen Behandlung der Quantentheorie, die bekanntlich bisher nur zu Teilerfolgen geführt haben, sind in dem Buche nicht berücksichtigt. So ist es dem Verfasser nach meiner Ansicht gelungen, eine systematische Behandlung derjenigen Methoden und Ergebnisse der Relativitätstheorie zu geben, die dazu berufen zu sein scheinen, in jede spätere, in den Mechanismus des Geschehens tiefer eindringende Theorie einzugehen.

Besonders eingehend sind diejenigen Gegenstände behandelt, an deren methodischem Ausbau der Verfasser selbst hervorragend beteiligt war: die relativ-

istische Fassung der Thermodynamik und das sogenannte kosmologische Problem, d.h. das Studium der Struktur des Raum-Zeit-Kontinuums im Grossen, welches von der räumlichen Ungleichmässigkeit der (astronomischen) Materie-Verteilung im Kosmos abstrahiert. Bezüglich des kosmologischen Problems eine Bemerkung, die sich nicht nur auf dies Buch, sondern auf alle neueren Publikationen über diesen Gegenstand bezieht: Die Einführung der kosmologischen Konstante in die "Feld"-Gleichungen war zunächst eine scheinbare Notwendigkeit, solange man daran festhalten zu müssen glaubte, dass die mittlere Dichte der Materie bzw. Energie in der Welt von der Zeit unabhängig sei. Die Einführung einer solchen Konstante ist aber vom theoretisch-formalen Standpunkt eine reine Willkür. Seitdem empirisch die Expansions-Bewegung der Stern-Systeme bekannt geworden ist, besteht vorläufig für die Einführung jenes Gliedes weder ein logischer noch ein physikalischer Anlass. Es scheint deshalb natürlich, bei der Behandlung des kosmologischen Problems von der Einführung des  $\Lambda$ -Gliedes abzusehen, solange sich für dessen Einführung keine zwingenden Gründe in der Erfahrung gefunden haben.

Besonders verdienstlich finde ich an Tolman's Buch die erschöpfende Behandlung der für die Nebel nach der Theorie zu erwartenden Gesetzmässigkeiten; denn diese erscheinen in erster Linie dazu geeignet, unsere Kenntnisse über die Struktur des Raum-Zeit-Kontinuums zu vervollständigen.

ALBERT EINSTEIN



## COLLOIDAL PHENOMENA AND CLASSICAL THEORY

*Colloid Chemistry.* By ARTHUR W. THOMAS. McGraw-Hill Book Company, Inc., pp. 1-512, \$4.00, 1934.

APPLICATIONS of classical chemical theory to the phenomena of colloidal chemistry have become increasingly numerous and successful in recent years. Professor Thomas has adopted this point of view in his "Colloid Chemistry" with marked success. The more important phenomena have been discussed in detail with complete references to the literature, but the book does not attempt to cover the entire field. "Clouds and Smokes," "Brownian Movement," "Liquid Dispersed Systems," "The Nature of Micelles" are thoroughly discussed and interpreted from the point of view of classical chemistry. Protein and carbohydrate colloids are discussed separately and Loeb's theory of the behavior of protein solutions is accepted in general. There are shorter discussions of precipitation by electrolytes, surface phenomena, absorption, foams, emulsions, gels and jellies, and also chapters on the experimental methods, such as dialysis and ultra-filtration and the preparation of colloidal solutions.

In the reviewer's opinion the experimental part is relatively too detailed, while some of the subjects, such as gels and jellies, could be expanded to advantage. The biological phenomena, such as agglutination of bacteria, the precipitin reaction and enzyme reactions are not discussed. On the whole the book furnishes a very clear introduction to the theory of colloidal reactions.

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## THE PRACTICAL APPLICATIONS OF ACOUSTICS

*Applied Acoustics.* By OLSON AND MASSA. P. Blakiston's Son and Company. Pp. 430 + xiv, 1934.

ACOUSTICS, as one of the classical divisions of physics, has been a field of investigation for many distinguished philosophers and scientists from ancient times. The great mass of our present knowledge of the subject in its more purely scientific aspects is contained in the classical works of v. Helmholtz and Lord Rayleigh, but through the development of new instrumental means of investigation and the coordinate development and invention of other scientific apparatus during the past few decades, greater progress has been made in experimental acoustics, and in its application to our daily life, than in all previous times. This development was also facilitated through the general recognition of the close relationship be-

tween the problems of acoustics and of electrical circuits.

A number of excellent treatises have been published in the last few years which have presented these modern developments from different points of view. The book under review deals with the subject, especially with reference to its modern applications. The authors, as physicists in the laboratories of one of our larger industrial organizations interested particularly in the manufacture of acoustical equipment, have themselves made a number of notable contributions. They are therefore well qualified to give up-to-date information on the present status and trend.

The greater portion of the book is devoted to a description of the characteristics of the more important types of modern electro-acoustic transducers, such as microphones, receivers and loud speakers, and of methods for determining their performance. Emphasis is laid particularly on such instruments as have found application in radio broadcasting and talking pictures. The illustrations for these are taken mainly from the laboratories or manufacturing department of the organization with which the authors are connected.

The book limits itself to those instruments and methods which will be found useful in a modern acoustical engineering laboratory. No mention is therefore made of acoustical research methods which may have considerable historic interest but little use to-day. A chapter each is devoted to architectural acoustics and noise measurements.

The discussion within the descriptive part of the book, while entirely sound, is in a form that may be easily followed by any one familiar with the elements of mechanics and of alternating current theory. For those wishing to obtain a more thorough understanding of the principles underlying applied acoustics several chapters at the beginning of the book are devoted to fundamental classical and modern acoustical theory. For the reading of these a somewhat wider mathematical knowledge is required.

The book should be helpful to students who wish to familiarize themselves with the latest developments in applied acoustics, as well as to research workers of acoustical laboratories.

E. C. WENTE

## A MANUAL OF THE RUSTS

*Manual of the Rusts in United States and Canada.* By JOSEPH CHARLES ARTHUR. Purdue Research Foundation, Lafayette, Indiana, pp. xv + 438, with 487 figs., 1934.

THE plant rusts with their complicated life-histories conditioned by variable spore-forms, strict parasitism and heteroecism have always been a difficult group taxonomically. The earlier and most of the later investigations have been analytic. We have

names based on separate spore-stages, host-specialization and obscure structural characters. In the present manual the author has taken the great mass of details accumulated by these numerous and varied analytic studies and has attempted to synthesize them in a manner to show new conceptions of relationship. A presentation is here available which combines the practical view-point of identification with the biological consideration of relationship and does it without much nomenclatorial disturbance. Even if the detailed results are not always acceptable the method is stimulating and the objective laudable. Botanical science is fortunate to have this notable work from the laboratories of one so eminently qualified by years of research devoted to this group of parasitic plants. Long experience and availability of a great collection are important factors in the development of such a contribution.

There are many collectors who will welcome a book which will be serviceable in the determination of species of rusts. The treatment of this group in Vol. 7 of the North American Flora (New York Botanical Garden) while entirely systematic is without notes or illustrations and is based on a classification difficult for any but the specialist to master. A book on the "Plant Rusts," by Dr. Arthur (and several collaborators) in 1929 is biologic and not systematic.

The present volume supplements these earlier works and fills a need not supplied by them. For some years there have been available systematic treatments of the Uredinales by various authors for England, Switzerland, Australia, New Zealand, South Africa and many other regions. There are also available numerous state lists (California, Indiana, Oregon, Delaware, Pennsylvania, etc.) by different authors, but this is the first workable comprehensive account for the United States and Canada. Greenland, Newfoundland, Alaska and the Aleutian Island are included.

There are several features of great biological interest. One of these is the record, even though brief, of cultures. The vast amount of such work which has been carried on by the author and his assistants can not fail to make an impression. Cultures have been a most important aid in establishing species, completing life histories and determining relationships.

The classification which the author says shows "the relationship of species and genera as consistent with the present state of knowledge as lineal arrangement permits" is also of biological interest. Two families are recognized, the Melampsoraceae and the Pucciniaceae, the first represented by four tribes and the second by three. There are in all 32 genera and 5 form-genera. Many workers who are familiar with Vol. 7 of the North American Flora will be glad to see the genera *Puccinia* and *Uromyces* reappear. Equally satisfactory is the inclusion of microcyclic

and macrocyclic species, formerly referred to distinct genera by the author, in the same genus. Specific identity is maintained. This arrangement makes it possible to indicate relationships more clearly. To show relationship still further some genera are subdivided into sections rather than splitting them into separate genera, and some species are subdivided into varieties rather than separating them into species. The most novel feature to indicate relationship is what might be called the "aggregate species." This is really a group of forms, more or less distinct, considered to represent a broken ancestral species. The group is treated in the key as if it were still one species, but the nomenclature is arranged so that each component retains its identity. In this way are brought together full cycle and reduced species which are beyond doubt related. This method of grouping is carried out to the greatest extent in the genus *Puccinia*. By using a single number for these "aggregates" the author states that he has reduced the numbers for this genus in the key from 419 to 332 or approximately 26 per cent.

A desire to accept the International Rules of Nomenclature is expressed, but "two deviations" are admitted, one an exception and the other an interpretation. The case for taking these liberties is well presented. The exception is the date for the beginning of nomenclatorial priority, 1753 and not 1801 being used. It is claimed that following the rule would mean the substitution of five unfamiliar specific names for well-known names.

The interpretation has to do with the question of whether names applied in the form-genus *Uredo* are to be recognized. The rule is not clear, but the argument presented by Dr. Arthur in favor of their recognition is clear and doubtless will be convincing to many mycologists. It is very certain that according to the rules names applied to aecial stages are excluded from nomenclatorial priority and this Dr. Arthur accepts. But as to the other point the rules read that names applied to the "perfect state" must be recognized and defines the "perfect state" not as the teleutospore or its equivalent but as that which "ends in the teleutospore or its equivalent." The uredo stage is a part of the "perfect state" under such a definition, and in this work recognition is given to it.

The press work and make-up of the book are attractive. An interesting feature is a list of authors for rust species (prepared with the assistance of Dr. J. H. Barnhart). Four pages are required for this list. Many of us will be glad to have this to consult in order to know the full name of the various workers. The dates of birth, and of death for those not contemporary, are added and serve to make the list still more interesting. A short glossary is included. A



review would be incomplete without favorable reference to the illustrations, all of which have been provided by Mr. George B. Cummins, of Purdue University. Unnecessary apology is made because space does not permit the depiction of variation in the

shape and size of the spores. The illustrations are well done and will be much appreciated by all users of the book.

FRANK D. KERN

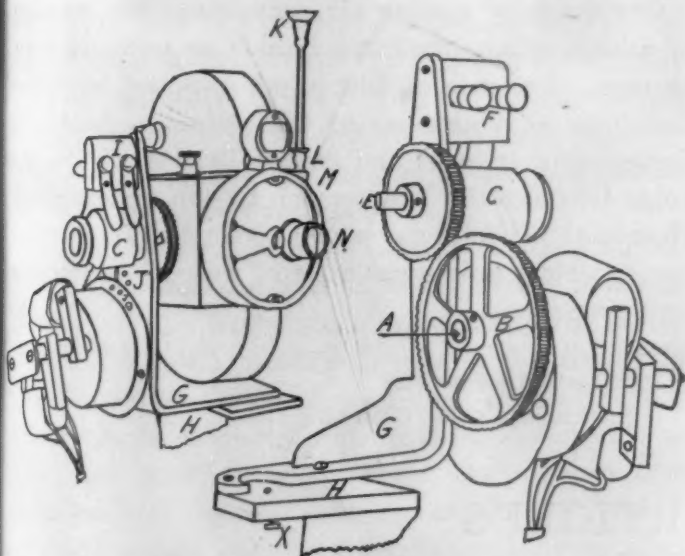
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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### FLEXIBLE CONTROL OF SPEED AND FOCUS FOR MOTION PICTURE CAMERAS

MANY phenomena of nature that progress slowly can be studied to advantage from motion picture photographs taken at appropriate intervals of time. The film may be speeded up to a convenient duration and repeatedly shown until the process is familiar to the experimenter and his audience. Such equipment has been used for many years<sup>1</sup> and the chief remaining difficulties to be solved in adapting the motion picture camera for such records are a constant speed motor and a simple means of focusing the camera.

The larger double telechron motor (M-43) is light enough to be attached readily by a bracket (G) to the stand (H) supporting the camera, Figs. 1 and 2.



Figs. 1 and 2. Telechron motor and the attachment to the stand (H) which supports the motion picture camera.

As there is practically no vibration, no special mounting is necessary when the stand is placed on a rubber kneeling pad held by bolts to the baseboard with a rubber stopper between the stand and the bolthead. A motor may be obtained with a built-in reducing gear so that the motor shaft (A, Fig. 1) will turn one revolution per minute. Suitable gears (B and D) may be interposed to give the camera drive shaft (E) any desired speed. One of the bolts holding the motor should have several positions (JJ', Fig. 2) to allow for the different distances between the shafts when the gear combinations have a different total

number of teeth. These inexpensive gears may be changed easily to give the outfit the necessary flexibility which is lacking in the commercial models now on sale at prohibitive prices. A drum (C) is provided with electrical contacts (F and I) so that a magnetic shutter may be operated synchronously with the camera.

The telescope (K) of a nasal pharyngoscope<sup>2</sup> may be used to see the focus of the image on the film in the camera. A bracket (M) gives strength and support and a movable stop (L) holds the pharyngoscope at the proper level in the camera. The stop will also hold it above the film when it is not being used or it may be removed entirely from the camera and a stop placed in the hole to exclude light. The tube of the pharyngoscope is small enough to pass between the shutter and the film gate of the camera. This is usable only when the camera shutter is open but does save the cost of a beam-splitter.

This arrangement is especially useful when photographing small objects or making titles. When the camera is used with the lower powers of the microscope, sufficient light is passed for focusing with the aid of the pharyngoscope. With the higher powers of the microscope, there is not enough light for visual focusing in the above manner and, in that case, a beam-splitter is required. Even when the beam-splitter is used, the pharyngoscope is useful in timing the shutter and in addition, it may be used to focus the image of a watch on the corner of the film frame by means of suitable auxiliary lenses. A detailed description of the complete apparatus will be published in the near future.<sup>3</sup>

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### AN APPARATUS FOR CONSTANT DELIVERY OF EQUAL WEIGHTS OF TWO OR MORE LIQUIDS

AN apparatus which delivers several liquids at a constant rate and at the same speed for each liquid

<sup>2</sup> This focusing device was described at the second annual meeting of the Biol. Photog. Assoc. in Rochester, September, 1933.

<sup>3</sup> A grant from the Bache Fund of the National Academy of Sciences made possible the construction of this apparatus, which will be described in detail in the *Jour. Biol. Photog. Assoc.*, 1934.

<sup>1</sup> O. O. Heard, *Jour. Biol. Photog. Assoc.*, 1: 4-19, 1932; O. W. Richards, *ibid.*, 2: 39-55, 1933.

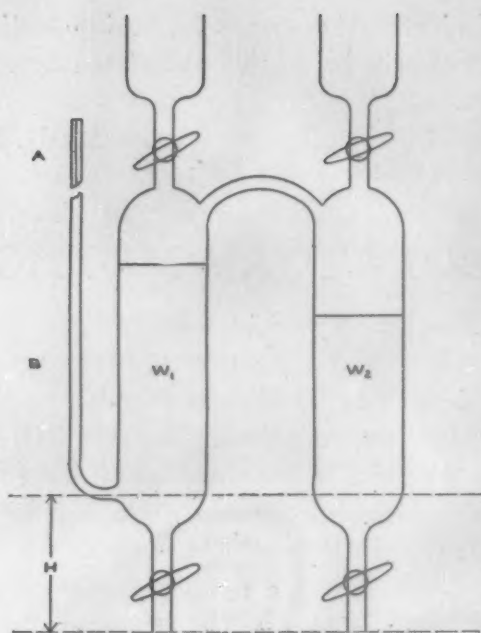


FIG. 1.

independent of density or viscosity is shown in Fig. 1. The system  $W_1$ ,  $W_2$  with the intervening air space acts as a balance so that if  $W_1$  becomes momentarily lighter than  $W_2$  owing to the liquid having run out faster, it necessarily slows up and  $W_2$  speeds up until the weights are again equal. By the use of a side arm B the hydrostatic head is made equal to H until the level of  $W_2$  reaches that point. It is preferable that the liquid in  $W_1$  be the less viscous since air bubbles pass through it.  $W_1$  may be used as a control liquid only and not one of those to be used for experimentation.

The rate of flow is governed by the capillary A. If the flow is to be varied a number of capillaries of different lengths or bore may be kept in hand so that by means of rubber connections the rate may be quickly changed.

Fig. 2 shows results of an experiment in which glycerine of specific gravity 1.25 and water at 1.0 and of viscosities 4.9 and 0.0089, respectively, were used as the liquids.

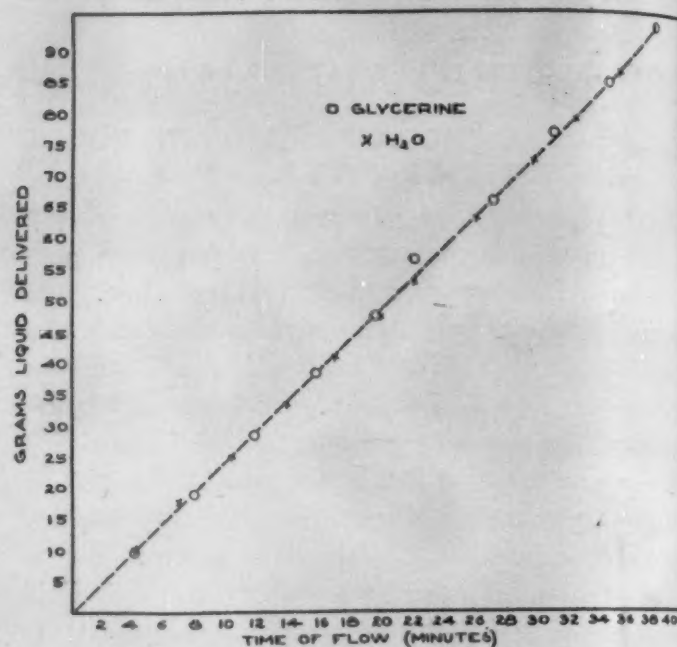


FIG. 2.

Obviously by similar air connections any number of added tubes containing liquids or solutions may be used. The rate of flow is not governed by either the shape or dimensions of the container, since it is dependent only on H and the capillary A. The same holds true for the temperature of the system above H so that the solutions may be at different temperatures and yet give equal rates of flow in weights per unit time.

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## SPECIAL ARTICLES

### THE SPIRAL GROWTH OF SINGLE CELLS

It is clear that all cases of spiral growth or movement in organisms are not produced by the action of the same factors, even though it is possible in a general way to describe the twisted or helical forms of growth as due to the resolution of two growth vectors, one longitudinal and one rotational. Whatever may be the ultimate explanation of twisting of such complex structures as trees, it is exceedingly interesting that spiral structure is exhibited by so many single plant cells. The spiral layers of the walls of wood cells, the coiled chloroplasts of *Spirogyra*, the whole organization of the coenocytic cells of *Chara* and *Nitella* and the spiral growth of the fungus *Phycomyces* may be taken as examples. It remains to be shown, of course, whether the spiral form of multi-

cellular plants is referable in some way to the spiral growth of their cellular components. At the moment the need is for an analysis of the cause of spiral growth in the simplest cells available.

The only living plant cell in which it has been possible to measure simultaneously growth and twisting about the long axis is the coenocytic spore-bearing cell of *Phycomyces*, where Oort<sup>1</sup> found at 17.5° C. an average rate of elongation of 39  $\mu$ /min. and an average rate of rotation of 3.7° per minute. For cells of diameter 114  $\mu$ , the angle which the main direction of growth makes with the longitudinal axis of the cell (therefore the inclination of the spiral, and the angle at which micellae are incorporated into the chitinous

<sup>1</sup> A. J. P. Oort, *Proc. Acad. Sci. Amsterdam*, 34: 564, 1931.



wall) is on the average about  $6^\circ$ . It has frequently been suggested<sup>2,3,4</sup> that the direction of protoplasmic streaming determines the orientation of spiral structure in the cell wall. Oort and Roelofsen<sup>5</sup> found that in the lower, non-growing part of the sporangio-phore of *Phycomyces* spiral protoplasmic streaming indeed occurred, but were not able to observe oriented streaming at the actual zone where growth took place.

In an attempt to learn something about the nature of the "rotational vector" in the growth of cells of this type, the rates of elongation and of rotation of sporangio-phores of *Phycomyces* were determined at  $15^\circ\text{C}$ . and at  $25^\circ\text{C}$ . The temperature coefficients for this interval were in 5 cases as follows:  $Q_{10}$  growth = 1.1, 1.1, 1.2, 1.6, 1.1;  $Q_{10}$  rotation = 2.5, 3.0, 2.4, 2.5, 1.6. Taken at their face value, these results indicate that the forces involved in twisting the cell have a significantly higher temperature coefficient than those concerned with its elongation. As a necessary consequence, moreover, the angle which the spiral makes with the long axis of the cell is greater at the higher temperature. For the five cells mentioned, the angles at  $15^\circ\text{C}$ . were  $3.3^\circ$ ,  $5.6^\circ$ ,  $8.6^\circ$ ,  $6.3^\circ$  and  $9.3^\circ$ ; at  $25^\circ\text{C}$ . these angles were, respectively,  $10.8^\circ$ ,  $15.6^\circ$ ,  $15.6^\circ$ ,  $11.6^\circ$  and  $11.1^\circ$ . It is evident, therefore, that the steepness of the growth spiral is not structurally fixed, but that it can be (reversibly) altered by change of temperature. This supports the view that the spiral form of growth in these cells is indeed due to the resolution of two vectors.

Raising the temperature of the cells above  $25^\circ\text{C}$ . further increases the rate of rotation up to about  $27.7^\circ\text{C}$ . At this temperature rapid elongation of the cell continues, but rotation is greatly diminished in rate, frequently abolished altogether, or occasionally reversed in direction. No mention has been made so far of the direction of rotation. Oort<sup>6</sup> found that the majority of the cells grew upwards in the form of a "right-handed" spiral. This corresponds to what we call a left-handed thread on a screw. In the studies which are described here, most of the cells from a totally different stock of the same strain of fungus showed similar "right-handed" spiral growth.

The question as to what determines the direction of spiraling of cells or organisms is possibly a separate problem. It has frequently been approached by conducting a survey, sometimes extending into the cosmos, of the direction of spiraling found in nature.<sup>7,8,9</sup> Unfortunately, no satisfactory general

explanation is forthcoming. The abolition of spiral growth or its reversal in *Phycomyces* by change of temperature suggests that relatively homely factors may control the direction as well as the magnitude of the process. The rapidity with which changes in the angle of spiraling may come about seems to argue against any interpretation in terms of altered proportions of different types of isomeric molecules. It is possible that the direction in which the protoplasm streams orients molecules which are being built into the wall,<sup>10</sup> and that at the higher temperatures the streaming protoplasm reaching the growing zone is not stably oriented. The suggestion that the rotational vector in spiral growth is streaming protoplasm is not intended to explain one unknown in terms of another: we know that there is movement and consequently force in protoplasmic streaming. If this idea were correct it would remain to discover what kinds of forces are at work in initiating and maintaining protoplasmic movement, but two problems would have been united. The experimental results briefly reported here show how relatively simple factors may profoundly modify the magnitude and direction of the rotational vector in spiral growth and suggest the value of experiments designed to test the rôle of protoplasmic streaming.

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#### EFFECT OF FLOWER PRODUCTION ON RATE OF GROWTH OF VEGETATIVE SHOOTS OF LONGLEAF PINE

WHILE working in a young stand (about 25 years old) of longleaf pine (*Pinus palustris* Miller) on April 8, 1931, I noticed a remarkable variation in the length of the terminal shoots. A close examination revealed that invariably those shoots which bore staminate strobili were short, while those which bore pistillate strobili or no strobili at all were quite long. The question suggested itself whether the production of the strobili may have had some influence on the rate of growth of the terminal shoots. Accordingly, 15 trees were numbered, and on each of these 10 to 20 terminal shoots were tagged with metal tags at different parts of the tree for a permanent record. The length of each shoot was measured from the base to the tip and the sex and number of strobili on each were recorded. On September 11 of the same year, the marked shoots were remeasured. The results appeared quite significant, suggesting a problem that has not yet received sufficient attention.

<sup>2</sup> L. Dippel, *Abh. Naturf. Ges. Halle*, 10: 55, 1868.

<sup>3</sup> E. Strassburger, "Ueber den Bau und das Wachstum der Zellhäute," Jena, 1882.

<sup>4</sup> G. van Iterson, *Hand. 23e Ned. Nat. en Geneesk. Congres*, 4, 1931.

<sup>5</sup> A. J. P. Oort and P. A. Roelofsen, *Proc. Acad. Sci. Amsterdam*, 35: 898, 1932.

<sup>6</sup> *Loc. cit.*

<sup>7</sup> H. Günther, *Biol. Cent.*, 39: 513, 1919.

<sup>8</sup> Th. Schmucker, *Beih. Bot. Cent.*, 41: 51, 1925.

<sup>9</sup> G. van Iterson, *loc. cit.*

<sup>10</sup> *Ibid.*

TABLE I

No. trees studied	Aver. diam. breast-high	No. shoots studied	Sex on shoots	Aver. length of shoots		Aver. length of leaves		Shoots dead, May, 1932		No. strobili on shoots		
				Apr. 8, 1931	Sept. 11, 1931	Apr. 8, 1931	Sept. 11, 1931	No.	Per cent.	Max.	Min.	Aver.
15	19.0 cms	51	Vegetative	68.4	102.4	0	302.2	3	6	—	—	—
		18	Pistillate	93.0	162.0	0	318.0	0	0	2	1	1.5
		89	Staminate	36.6	74.1	0	283.5	28	31	72	2	19.2

In Table I are given the measurements of the shoots and the sex of flowers they bore. Those which bore no strobili were for convenience designated as vegetative shoots. The results show that in all the 89 shoots bearing the staminate strobili the amount of the growth they had made was very small. In the early spring the shoots bearing the pistillate strobili were the largest and were nearly three times as long as those bearing the staminate strobili. Those bearing no strobili, or the vegetative shoots, were at the start about two thirds the length of those bearing the pistillate strobili and about twice as long as those bearing the staminate strobili. At about the end of the growing season the stems produced by the shoots bearing the pistillate strobili (which by now had been pollinated) were twice the length of the stems produced by those bearing the staminate strobili, while the stems produced by the vegetative shoots were about one and one half times as long as those produced by the male-bearing.

Another point of interest is the relation between the number of staminate strobili and the size of the shoot that bore them. In all cases it was evident that the shoots bearing the smaller number of staminate strobili were larger than those bearing the larger number of male flowers. In other words, the amount of growth made by the shoots bearing the staminate strobili varied inversely with the number of the strobili. This would indicate that the production of the staminate strobili caused a retardation in the growth of the terminal shoots bearing those strobili. On the other hand, the production of the pistillate strobili apparently caused a stimulation of the growth of the shoots that bore them, for in all cases those bearing the pistillate strobili were larger than those which bore no strobili. Field observation of mature trees showed, however, that the upper branches of the trees which were vigorous bore pistillate strobili, while those on the lower part of the tree bore the staminate strobili, suggesting that staminate strobili were produced on weaker branches. This then suggests the question of whether the slow growth of the shoots bearing the staminate strobili was due to their natural weak condition or whether the shoot actually

suffered a retardation in growth produced by the staminate strobili. In other words, the question is "Which is the cause and which the effect?"

A point in favor of the theory that the production of the pistillate strobili cause a stimulation in the growth of the shoot is shown by the greater growth of the needles on the shoots bearing the pistillate strobili than on those bearing the staminate strobili or on the vegetative shoots (see Table I).

It was also found by the end of the summer that while none of the pistillate shoots died, 6 per cent. of the vegetative shoots and 31 per cent. of the shoots bearing staminate strobili had died due to insect infestation.

In August, 1932, the area was again visited and observation made on the tagged shoots in order to determine whether the development of the pistillate cones after fertilization might retard the terminal growth of that branch during the development of the cones. It was found that six of the branches bearing the pistillate cones had long new shoots. Five of the pistillate cones examined during 1931 were destroyed by insects, but the terminal growth of that year (1932) was as long as during the previous year. However, as many of the tips of the branches bearing the staminate strobili in 1931 showed no growth in 1932, no further notes were made.

In conclusion, it may be stated that the question of the effect of flower production on the rate of growth of terminal shoots of pine is an open one and presents an excellent problem for further investigation.

L. J. PESSIN

SOUTHERN FOREST EXPERIMENT STATION

### BOOKS RECEIVED

- CASTIELLO, JAIME. *Geistesformung*. Pp. 142. Ferd. Dummlers Verlag, Berlin. M. 5.80.  
 GREGG, RICHARD B. *The Power of Non-Violence*. Pp. 359. Lippincott. \$2.50.  
 IVES, HOWARD C. *Mathematical Tables*. Second edition. Pp. vii + 160. Wiley. \$1.50.  
 TOKUNAGA, SHIGEYASU and NOBUO NAORA. *Report of the First Scientific Expedition to Manchoukou*. June-October, 1933. Section II: Part I. Pp. 119 + 7. Illustrated.